JAPANESE UNEXAMINED PATENT PUBLICATION

(A)

(11) Publication number : 02-192046

(43) Date of publication of application : 27.07.1990

(51) Int.CI. G11B 11/10

(21) Application no: 01-118330

(22) Date of filing: 11.05.1989

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(30) Priority

Priority no: 63265626 Priority date: 21.10.1988

Priority country: JP

(54) **Title of the Invention: Magneto-optical Recording Medium**

Specification

1. TITLE OF THE INVENTION

Magneto-optical Recording Medium

2. CLAIMS

(1) A magneto-optical recording medium comprising a substrate on which is provided at least a magnetic film and a reflective film,

said magneto-optical recording medium characterized in that said reflective view is comprised of silver (Ag) and manganese (Mn).

(2) A magneto-optical film as set forth in claim 1, characterized in that the rate of addition of manganese (Mn) in the silver (Ag)-manganese (Mn) is at least 2 (atomic%) to not more than 32 (atomic%).

(3) A magneto-optical recording medium comprising a substrate on which is provided at least a magnetic film and a reflective film,

said magneto-optical recording medium characterized in that said reflective view is comprised of silver (Ag), manganese (Mn), and tin (Sn).

(4) A magneto-optical film as set forth in claim 3, characterized in that the rate of addition of manganese (Mn) in the silver (Ag)-manganese (Mn)-tin (Sn) is 1 (atomic%) and the rate of addition of tin (Sn) is at least 1 (atomic%) and not more than 23 (atomic%).

(5) A magneto-optical film as set forth in claim 3, characterized in that the rate of addition of manganese (Mn) in the silver (Ag)-manganese (Mn)-tin (Sn) is 7 (atomic%) and the rate of addition of tin (Sn) is at least 1 (atomic%) and not more than 20 (atomic%).

(6) A magneto-optical film as set forth in claim 3, characterized in that the rate of addition of manganese (Mn) in the silver (Ag)-manganese (Mn)-tin (Sn) is 15 (atomic%) and the rate of addition of tin (Sn) is at least 1 (atomic%) and not more than 14 (atomic%).

3. DETAILED DESCRIPTION OF THE INVENTION

(Field of Utilization in Industry)

The present invention relates to a magneto-optical recording medium, more particularly relates to a magneto-optical recording medium having such a reflective film as to give excellent CN ratio (carrier-to-noise ratio) and recording sensitivity.

(Prior Art)

Magneto-optical recording media (hereinafter sometimes referred to in brief as "recording media") are the subject of active research and development as high-density recording media having a magnetic film adapted to rewriting .

Among magneto-optical recording media constituting the magnetic films of such recording media, amorphous alloys of a rare earth metal with a transition metal (hereinafter sometimes referred to as "RE-TM alloys") have been most progressed in studies and most put into practical use since they are formed into a perpendicular anisotropy film with direction of magnetization oriented perpendicularly to the surface of the film, have a large coercive force of several KOe, and are capable of being relatively easily formed into a film by a deposition technique such as sputtering or vacuum evaporation.

Since recording media produced using an RE-TM alloy have a perpendicular anisotropy film as the magnetic film thereof, they have excellent features of being capable of recording information up to an extremely high density of 10^8 (bits/cm^2) and being, in principle, capable of undergoing close to infinite repetition of erasing and rewriting information.

However, a magnetic film made of an RF-TM alloy is defective in that it has a poor corrosion resistance [see Reference I: "Hikarijiki Disk" (supervised by Nobutake Imamura and published by K. K. Triceps, p. 427)] and exhibits only a little magneto-optical effect (Kerr effect).

Thus, there are known structures of recording media which comprise a magnetic film as mentioned above and a reflective film provided on the side of the magnetic film opposite the reading side thereof and/or protective films provided so as to sandwich the magnetic film to increase the apparent Kerr rotation by utilizing the refraction or reflection of light

(see the above-mentioned Reference I, p.119).

The above-mentioned conventional magneto-optical recording media will now be described while referring to the accompanying drawings.

FIG. 5(A) is an explanatory view shown by a schematic cross-section for explaining an example of the configuration of a conventional recording media. In the fiture, the hatching showing the cross-section is partially omitted.

As will be understood from FIG. 5(A), a protective film 13a, a magnetic film 15, a protective film 13b, and a reflective film 17 are formed in this order on the surface of a substrate 11 to produce a recording medium 19.

Among these, the substrate 11 is made of a material which is transparent at the wavelength of a light to be used in writing in or reading from the recording media 19 such as a polycarbonate resin, glass, and epoxy resin.

The protective films 13a and 13b are formed by deposition of SiO, SiO_2, AlN, Si_3N_4 AlSiN, AlSiON, or other protective film material.

The magnetic film 15 is made of an RE-TM alloy as mentioned above. As such an alloy, for example, Tb-Fe alloys, Tb-Co alloys, Tb-Fe-Co alloys, and other combinations of rare earth metals and transition metals are known. .

In addition, as the material of the reflective film 17, reflective film materials such as aluminum (Al), gold (Au), silver (Ag), copper (Cu), and titanium (Ti) are known.

As the recording medium having a reflective film 17 as mentioned above, a recording medium 21 (see shown FIG. 5(B)) configured by forming on the surface of a substrate 11 a protective film 13a, a magnetic film 15, a reflective film 17, and a protective film 13b in this order is also known.

Information is written on such a recording medium according to the so-called thermomagnetic writing-based in

which an external magnetic field is applied and in that state a laser beam focused to a spot diameter of about 1 μm is emitted in the direction from the substrate 11 to the magnetic film 15. That is, the magnetic film 15 locally heated with the above-mentioned laser beam is lowered in coercive force. At that time, the external magnetic field carrying recording information writes the information in the magnetic film. Information may also be written by the pit length and/or interval of the laser beam mentioned above.

As can be understood from the foregoing description, the recording sensitivity of a magneto-optical recording medium is greatly affected by the heat retaining properties in the magnetic film thereof and the degree of multipath reflection.

Accordingly, when the reflective film is viewed from the foregoing point of view, the reflective film is required to be made of a material having not only such a low thermal conductivity as to suppress heat dissipation at the time of writing and to be made of a material with a high reflectivity so to give efficient multipath reflection at the time of reading.

(Problems to be Solved by the Invention)

As described above, when silver (Ag), among the conventionally known materials of reflective films, is used to form a reflective film, a CN ratio of about 48 dB can be attained because Ag has a high reflectivity. On the other hand, however, the thermal conductivity is large, so it was necessary to use a high energy as a recording power corresponding to the output of a laser beam for use in writing in order to make up for large heat dissipation from a magnetic film.

In view of the foregoing problem of the prior art, an object of the present invention is to provide a magneto-optical recording medium which permits writing with a smaller recording

power compared with the case of forming a reflective film made of silver alone and further has a practical readout sensitivity.

(Means for Solving the Problems)

To achieve this object, according a magneto-optical recording medium of a first aspect of the invention of this application, there is provided a magneto-optical recording medium comprising a substrate on which is provided at least a magnetic film and a reflective film, characterized in that said reflective view is comprised of silver (Ag) and manganese (Mn).

In working the first aspect of the invention, it is preferable to make the rate of addition of manganese (Mn) in the silver (Ag)-manganese (Mn) at least 2 (atomic%) to not more than 32 (atomic%).

Further, according to a magneto-optical recording medium of a second aspect of the invention of this application, there is provided a magneto-optical recording medium comprising a substrate on which is provided at least a magnetic film and a reflective film, characterized in that said reflective view is comprised of silver (Ag), manganese (Mn), and tin (Sn).

In working the second aspect of the application, it is preferable to make the composition of the reflective film comprised of the silver (Ag)-manganese (Mn)-tin (Sn) any of one:

(1) making the rate of addition of tin (Sn) at least 1 (atomic%) and not more than 23 (atomic%) when making the rate of addition of manganese (Mn) 1 (atomic%);

(2) making the rate of addition of tin (Sn) at least 1 (atomic%) and not more than 20 (atomic%) when making the rate of addition of manganese (Mn) 7 (atomic%); and

(3) making the rate of addition of tin (Sn) at least 1 (atomic%) and not more than 14 (atomic%) when making the rate of addition

of manganese (Mn) 15 (atomic%).

(Mode of Operation)

The magneto-optical recording medium of the first aspect of the invention of this application has a reflective film comprising silver (Ag) capable of providing a high CN ratio and manganese (Mn). Therefore, by including Mn, it is possible to reduce the recording power compared a reflective film made of Ag alone.

The magneto-optical recording medium of the second aspect of the invention of the present invention has a reflective film comprising silver (Ag) capable of providing a high CN ratio and a combination of manganese (Mn) and tin (Sn). The addition of Mn and Sn enables the recording power of the recording medium to be reduced as compared with a reflective film made of Ag alone.

(Examples)

Examples of the present invention will now be described while referring to the accompanying drawings. While the following described examples are explained by preferable examples of numerical values and other conditions falling within the scope of the present invention, it should be understood that these are simple illustrations and that the invention is not limited to only these conditions.

Example 1 is concerned with a combination of silver (Ag) with manganese (Mn) to form a reflective film in accordance with the first aspect of the present invention, while Example 2 is concerned with a combination of silver (Ag) with manganese (Mn) and tin (Sn) to form a reflective film in accordance with the second aspect of the present invention.

Example 1

First, in Example 1, a plurality of magneto-optical recording media formed with reflective films comprised of silver (Ag) and manganese (Mn) changed in rates of addition

of Mn and differing in thicknesses were examined with respect to recording power and CN ratio.

<Production of Magneto-optical Recording Media>

First, the procedure of producing a magneto-optical recording medium serving the sample to be examined will be described while referring to the figures.

In this example, a recording medium was produced by the configuration shown in the above-mentioned FIG. 5(B), then a protective film 13a, a magnetic film 15, a reflective film 17, and a protective film 13b were sequentially formed on the surface of a substrate 11 to produce a magneto-optical recording medium 21 as a sample to be examined.

First, the protective film 13a having a thickness of 700Å and made of silicon aluminum nitride (AlSiN) was deposited on the surface of the substrate 11 made of a polycarbonate. The deposition was performed by a magnetron sputtering method. The deposition conditions included a supplied power of about 500W and an argon gas pressure of 3 mTorr.

Subsequently, the magnetic film 15 having a thickness of about 300Å was deposited on the surface of the protective film 13a using a target composed of terbium, iron, and cobalt at a ratio of 22:70:8 in terms of the number of atoms under the same deposition conditions as described above according to the same deposition method as described above.

Next, the above protective film 13b was formed on its surface with a reflective film 17 of different rates of addition of Mn and thickness by changing the Mn addition rate in the Ag and Mn within the range of 0 to 45 atomic % and making the thickness 200Å, 300Å, and 400Å.

The deposition conditions, in the same way as described above, included a supplied power of about 500W and an argon gas pressure of 3 mTorr. By changing the ratio of areas of the surface subjected to sputtering when stacking targets

comprised of the single metals, the Mn addition rate was varied.

Thereafter, the above-mentioned reflective film 17 had deposited on its surface a protective film 13b made of AlSiN by the same deposition conditions and thickness as in the protective film 13a to thereby obtain a plurality of magneto-optical recording media 21 having different compositions of reflective films 17 as measurement samples.

<Proedures of Measuring Characteristics>

Next, a description will be made of the procedures of measuring the recording power and the CN ratio of the recording media of the above measurement samples.

First, when measuring the recording power of the samples, the recording conditions were standardized to the use of light having a wavelength of 830 nm, a rotation of 1,800 rpm, a duty of 33%, and a recording frequency of 3.7 MHz.

The CN ratio was measured by writing by a recording power in accordance with each sample under the above conditions, then reading by a reading power of 1.0 mW and a band width of 30 kHz.

<Results of Measurement of Characteristics>

Next, the relationships of the results of measurement of the recording power and the CN ratio as measured above and the Mn addition rate in theAg-Mn will be described while referring to the figures.

FIG. 1 is a diagram showing correlation curves with the ordinate and the abscissa representing the recording power (mW) and the Mn addition rate (atomic%) in the Ag-Mn reflective film-baseds, respectively, which is illustrative of the relationship between the Mn addition rate and the recording power. In the figure, the curve a is concerned with samples having a reflective film of 400Å in thickness, the curve b with samples having a reflective film of 300Å in thickness,

and the curve c with samples having a reflective film of 200Å in thickness.

As can be understood from FIG. 1, in the case of samples having an Mn addition rate of 0 atomi% in the reflective film (corresponding to reflective film made of Ag alone), the recording power varied depending on the thickness of the reflective film. It was about 8.0 mW for a thickness of 400Å, about 6.2 mW for 300Å, and about 5.4 mW for 200Å.

In contrast, the recording power was decreased as the Mn addition rate was increased. For example, in the case o samples produced at a Mn addition rate of 2 atomic% (corresponding to a reflective film having a composition represented by the formula: $Ag_{98}Mn_2$), the recording power cou be decreased to be about 6.0 mW for a thickness of 400Å, about 5.0 mW for 300Å, and about 4.4. mW for 200Å.

In the case of the samples having a reflective film of 400Å in thickness, as can be understood from the curve a, the recording power tended to be decreased as the Mn addition rate was increased from 2 atomic% as mentioned above. A recording power of about 4.0 mW was obtained for a sample produced at an Mn addition rate of 45 atomic%. However, no substantial decrease in the recording power could be secured even when the Mn addition rate was increased to more than 45 atomic%.

By contrast, it will be understood that, in the case of making the thickness 300Å (curve b) or 200Å (curve c), the recording power once showing a decreasing tendency again ends up increasing as the Mn addition rate is increased.

Next, a description will be made of the relationship between the measurement results of the CN ratio and the Mn addition rate as regards the recording media of Example 1 while referring to FIG. 2.

FIG. 2 is a diagram showing correlation curves with the ordinate and the abscissa representing the CN ratio (dB) and

the Mn addition rate (atomic%) in the Ag-Mn which are illustrative of the relationship between the addition rate and the CN ratio. In this figure as well, like in FIG. 1, the curves are assigned notations corresponding to thc thicknesses.

As can be understood from FIG. 2, in the case of samples having an Mn addition rate in the reflective film of 0 atomic% (corresponding to a reflective film made of Ag alone) (curve a), the CN ratio was about 48.0 dB irrespective of the thickness. No substantial decrease in the CN ratio due to the increase of the Mn addition rate was recognized in the range of the Mn addition rate of up to about 7 atomic% (corresponding to a reflective film of $Ag_{93}Mn_7$). The value of about 48.0 dB was maintained. It can be understood that the CN ratio falls as the Mn addition rate is increased beyond the above-mentioned 7 atomic%. The smaller the reflective film thickness, the stronger the degree of the drop. In the case of recording media produced at an Mn addition rate of 45 atomic% ($Ag_{55}Mn_{45}$), the CN ratio was about 44.0 dB for a thickness of 400Å (curve a), about 43.0 dB for 300Å (curve b), and about 39 dB for 200Å (curve c).

Next, a description will be made of the preferable range of Mn addition rate in a reflective film comprised of Ag-Mn of the first aspect of the present invention while referring to FIG. 1 and FIG. 2.

As will be understood from the results shown in the two diagrams of correlation curves, the relationship between the Mn addition rate and the recording power differs depending on the thickness of reflective film. When making the thickness 400Å, the recording power can be decreased by increasing the Mn addition rate. In contrast, when forming the reflective film by a thickness of not more than 300Å, an increase in the Mn addition rate deteriorates the reflection characteristics

to increase light transmission therethrough and to rather lower the CN ratio and increase the recording power.

As will be understood from the curves shown in FIG. 1, it is possible to reduce the recording power by increasing the MN addition rate in a relatively low range. Here, if taking note of the inclination of the curves, it will be understood that the inclination starts to gradually become smaller from around the Mn addition rate of about 3.5 atomic%. Therefore, the lower limit of the Mn addition rate in the Ag-Mn is preferably made at least 2 atomic% including the above value.

As for the CN ratio, when writing by a speed of 1,800 rpm and a frequency of MHz according to the international standard of the ISO (International Organization for Standardization), it is required that at least 45 dB be satisfied. Therefore, it will be understood that it is sufficient to find the Mn addition rate satisfying this standard from FIG. 2 and make the addition rate 32 atomic% or lower.

As will be understood from the foregoing description, to obtain a reflective film enabling writing with a smaller recording power than when forming a reflective film by silver alone and having a practical reading sensitivity, it is sufficient to make the Mn addition rate in the Ag-Mn not less than 2 atomic% and not more than 32 atomic%.

Example 2

In Example 2, a description will be made of the results of measurement of the recording powers and CN ratios of samples formed with reflective films made of silver (Ag), manganese (Mn), and tin (Sn) while changing the Mn and Sn addition rates. The characteristics were measured and the recording media serving as samples in that measurement were prepared by the same conditions as in Example 1. Therefore, to avoid duplicate explanations in the following description, only the results

of measurement will be described by reference to the figures. Further, in changing the addition rates of Mn and Sn, a plurality of recording media was prepared while changing only the addition rate of Sn under the same Mn addition rate in Ag-Mn-Sn. Further, in this example, the results of measurement of recording media prepared having a reflective film of 400Å in thickness and recording media prepared having a reflective film of 200Å in thickness will be explained.

FIGS. 3(B) and 3(B) are diagrams showing correlation curves with the ordinate and the abscissa representing the recording power (mW) and the Sn addition rate (atomic%), respectively, which are illustrative of the relationship of the recording power with the Mn addition rate and the Sn addition rate in the Ag-Mn-Sn. In these diagrams, FIG. 3(A) is a diagram showing corresponding curves illustrating the results of measurement in the case of making the thickness of the reflective film 400Å, while FIG. 3(B) is a diagram showing correlation curves illustrating the results of measurement when making the thickness of the reflective film 200Δ. In the figures, the curves I illustrate the results of measurement of samples prepared without the addition of Mn and with the composition of Ag and Sn changed in various ways for comparison with reflective films according to the second aspect of the invention. Further, curves II to V illustrate the results of measurement of a plurality of samples prepared while making the Mn addition rate a fixed 1 atomic%, 7 atomic%, 15 atomic%, or 30 atomic% and changing the Sn addition rate within the range of 0 to 35 atomic%. To facilitate the understanding of the invention relating to these curves, the curve I has appended to it "$Ag_{100-x}Sn_x$", the curve II "$Ag_{99-x}MnSn_x$", the curve III "$Ag_{93-x}Mn_7Sn_x$", the curve IV "$Ag_{85-x}Mn_{15}Sn_x$", and the curve V "$Ag_{70-x}Mn_{30}Sn_x$" expressing generically the compositions of the reflective films of the measurement samples

shown by those curves.

First, in reflective films having a thickness of 400Å, from a comparison of curve I and curve II shown in FIG. 3(A), the extent of lowering the recording power is greater in the case of addition of 1 atomic% Mn and Sn to Ag compared with the case of addition of only Sn to Ag. Further, from a comparison of the curve I and the curves III to V, it can be understood that with a predetermined Sn addition rate, the larger the Mn addition rate taken in the recording medium, the smaller the value of the recording power obtained.

Next, specific values will be given of the relationship between the composition of the reflective film and the recording power shown in curves I to V of FIG. 3(A).

First, if comparing the recording power when making the Sn addition rate 1 atomic%, the recording power was about 7.6 mW for a recording medium plotted on the curve I (reflective film of $Ag_{99}Sn$), while was about 5.7 mW for a recording medium on the curve II ($Ag_{98}MnSn$), about 5.0 mW for a recording medium on the curve III (Ag_{92} Mn_7Sn), about 4.3 mW for a recording medium on the curve IV ($Ag_{84}Mn_{15}Sn$), and about 4.0 mW for a recording medium on the curve V ($Ag_{69}Mn_{30}Sn$).

If compared for the case where the Sn addition rate is 35 atomic%, which is the upper limit of measurement of the recording power in Example 2, the recording power was about 5.5 mW for a recording medium plotted on the curve I (reflective film of $Ag_{65}Sn_{35}$), about 4.1 mW for a recording medium on the curve II ($Ag_{64}MnSn_{35}$), about 3.8 mW for a recording medium on the curve III ($Ag_{58}Mn_7Sn_{35}$), about 3.6 mW for a recording medium on the curve IV ($Ag_{50}Mn_{15}Sn_{35}$), and about 3.3 mW for a recording medium on the curve V ($Ag_{35}Mn_{30}Sn_{35}$). Additionally stated, even when making the Mn addition rate a value larger than the above 30 atomic%, the recording power could be lowered in accordance with each Sn addition rate. As will be understandable from

a comparison of the curves II to V shown in FIG. 3(a), however, it is recognized that the extent of lowering the recording power obtained when increasing the Sn addition rate tended to become smaller the larger the ratio of Mn in the Ag-Mn-Sn reflective film.

Even in reflective films having a thickness of 200Å, from a comparison of the curve I and curve II shown in FIG. 3(B), the extent of lowering the recording power by addition of Sn to Ag and 1 atomic% Mn was larger in a recording medium adding Sn to Ag and 1 atomic% of Mn compared with a recording medium provided with an Ag-SZn reflective film. Further, from a comparison of curve I and curves III to V, it can be understood that when the thickness of the reflective film is a thin 200Å, the recording power is dependent on the Mn addition rate and the Sn addition rateand complicated changes are exhibited.

Specific values will now be exemplified for the relationship between the composition of the recording film and recording power shown by curves I to V of FIG. 3(B).

First, if comparing the recording power when making the Sn addition rate 1 atomic%, the recording power was about 5.5 mW for a recording medium plotted on the curve I (reflective film of $Ag_{99}Sn$), while was about 4.4 mW for a recording medium on the curve II ($Ag_{98}MnSn$), about 3.4 mW for a recording medium on the curve III ($Ag_{92}Mn_7Sn$), about 2.9 mW for a recording medium on the curve IV ($Ag_{84}Mn_{15}Sn$), and about 3.5 mW for a recording medium on the curve V ($Ag_{69}Mn_{30}Sn$).

As can be seen from FIG. 3(B), by increasing the Sn addition rate, it is possible to reduce the recording power compared with an Ag-Sn reflective film for any Mn addition rate within a comparatively low range of Sn addition rate, but the recording power tended to increase when the Sn addition rate was increased. This is believed to be because the reflective film is formed to a small thickness of about 200Å,

so the greater the Sn addition rate, the higher the permeability and therefore the inability for effective use of the recording power used for writing.

In an Ag-Mn-Sn reflective film, it can be understood that the larger the Mn addition rate used, the smaller the Sn addition rate when the recording power starts to increase.

Next, a description will be made of the relationship of the results of measurement of the CN ratio for the recording media of the above Example 2 with the Mn and Sn addition rates with reference to FIGS. 4(A) and (B).

FIGS. 4(A) and (B) are diagrams showing correlation curves with the ordinate and the abscissa representing the CN ratio (dB) and the Sn addition rate (atomic%), respectively, which are illustrative of the relationship of the Mn addition rate and the Sn addition rate as regards the recording media of Example 2 with the CN ratio. FIG. 4(A) shows the results in the case where the reflective film thickness was 400Å, while FIG. 4(B) shows the results in the case where the reflective film thickness was 200Å. The curves shown in these figures are assigned the notations of the curves I to V corresponding to FIGS. 3(A) and (B) and generic formula of the compositions of the reflective films of the recording media expressed by these curves.

First, in the case of recording media having comparatively thick reflective films of 400Å, as can be understood from the curves I to V shown in FIG. 4(A), a drop in the CN ratio was caused overall in recording media produced while adding Mn or Sn to silver. If showing the Sn addition rate causing a drop in the CN ratio to 45 dB of the aforementioned ISO international standard, this was about 32 atomic% for recording media produced without addition of Mn (curve I), about 28 atomic% for recording media produced with addition of 1 atomic% of Mn (curve II), about 24 atomic% for

recording media produced with addition of 7 atomic% Mn (curve III), about 18 atomic% for recording media produced with addition of 15 atomic% Mn (curve IV), and about 6.5 atomic% for recording media produced with addition of 30 atomic% Mn (curve V).

Next, as can be understood from the curves shown in FIG. 4(B), a drop in the CN ratio was caused overall in even in recording media having a comparatively thin reflective film of 200Å. If taking note of the Sn addition rate causing a drop in the CN ratio to 45 dB of the aforementioned ISO international standard, this was about 27 atomic% for recording media produced without addition of Mn (curve I), about 23 atomic% for recording media produced with addition of 1 atomic % Mn (curve II), about 20 atomic% for recording media produced with addition of 7 atomic% Mn (curve III), about 14 atomic% for recording media produced with addition of 15 atomic% Mn (curve IV), and about 3 atomic% for recording media produced with addition of 30 atomic% Mn (curve V).

As can be understood from a comparison of FIG. 3(A) and FIG. 4(A) and FIG. 3(B) and FIG. 4(B), by making the thickness of the reflective film of the same composition thinner, the CN ratio ends up falling. Therefore, to achieve a CN ratio able to be practically used and achieve a reduction of the recording power, when forming an Ag-Mn-Sn reflective film, it is necessary to set the Mn addition rate and Sn addition rate in narrower preferred ranges using as yardsticks the results obtained in the case of a small reflective film thickness.

Next, the preferable ranges of the Mn addition rate and Sn addition rate in the Ag-Mn-Sn reflective film of the second aspect of the present invention will be explained while referring to FIG. 3(B) and FIG. 4(B).

First, the preferable range of the manganese (Mn)

addition rate will be described.

First, as can be understood from a comparison of the curve I and the curves II to V shown in FIG. 3(B), if making the Mn addition rate at least 1 atomic%, an sufficient effect of reduction of the recording power is obtained compared with the case of adding only Sn to Ag.

On the other hand, taking note of the range of the Sn addition rate able to achieve a CN ratio of at least 45 dB shown in FIG. 4(B), the lowering of the CN ratio is relatively gentle within the range of a Sn addition rate of about 3 atomic% to about 7 atomic% in the curve IV (Mn addition rate 15 atomic%). This tendency can also be recognized in the curve II (Mn addition rate: 1 atomic%) and the curve III (Mn addition rate: 7 atomic%) as well. In contrast, in the curve V with an Mn addition rate of 30 atomic%, a continuous tendency of lowering of the CN ratio is seen with each of the Sn addition rates in the range of measurement. As can be understood from this, the preferable range of the Mn addition rate is not more than 15 atomic%.

As described above, it can be understood from the viewpoint of the effect of reducing the recording power and the lowering of the CN ratio that the preferable range of Mn addition rate is at least 1 atomic% and not more than 15 atomic%.

Next, the preferable range of tin (Sn) addition rate will be described.

First, from FIG. 3(B), if setting the Sn addition rate is set to at least 1 atomic% for a recording medium having a reflective film made of Ag alone having a recording power of about 5.7 mW, a 20% or more reduction of recording power can be achieved even with any of the Mn addition rates shown in the curves II to V.

As already described by reference to the results of measurement of the CN ratio shown in FIG. 4(B), the upper limit

Thereafter, the protective film 13b had deposited on its surface a reflective film 17 expressed by the formula $Ag_{86}Mn_7Sn_7$ as one example of the composition of the Ag-Mn-Sn reflective film according to the second aspect of the present invention to a thickness of 400Å or 200Å to obtain a magneto-optical recording medium 19 of Example 3.

The components including the protective layers were deposited under the same conditions as in Example 1 and Example 2 explained above.

Further, except for providing reflective films made of only Ag, recording media were produced under the same conditions. These two recording media were measured for recording power and CN ratio by the above-mentioned procedures and numerical values.

As a result, a recording power of 8 mW and a CN ratio of 50.4 dB were obtained for a recording medium according to the comparative example produced while making the thickness of the reflective film 400Å. On the other hand, a recording power of 5.7 mW and a CN ratio of 50.2 dB were obtained for a recording medium of the comparative example having a thickness of 200Å.

In contrast, a recording power of 4.5 mW and a CN ratio of 50.1 dB, which is substantially the same as those of the comparative examples, were obtained for a recording medium of Example 3 having a thickness of the reflective film of 400Å, while a recording power of 3.1 mW and a CN ratio of 50.0 dB were obtained for a recording medium of Example 3 having a thickness of 200Å.

As can be understood from these results, an improvement in CN ratio due to Kerr effect enhancement can be realized without lowering the recording sensitivity by changing the position of the reflective film in any of the recording mediu, of Example 2 according to this application and the conventional

recording medium. Therefore, in producing a magneto-optical recording medium by various stacked structures, it is possible to realize a higher CN ratio than the results measured for the recording media of Example 1 and Example 2 by using the invention of this application.

Above, examples of this application were explained in detail, but it is clear that the present invention is not limited to only the above examples.

For example, in the above examples, the substrate, magnetic film, and protective films forming the magneto-optical recording media were explained illustrating the materials, thicknesses, and other specific conditions. However, the present invention does not give the effects only when limited to these conditions.

Further, as examples relating to the first and second aspects of the invention, recording media having predetermined reflective film compositions were produced and preferable ranges were explained, but it is clear that the invention according to this application does not give the effects only in the preferred range. For example, in Example 2, for the purpose of facilitating the understanding of the description, predetermined Mn addition rates was illustrated and a study made of the preferred range of the Sn addition rate under conditions of fixed Mn addition rates. However, the range of composition of the Mn addition rate and Sn addition rate does not give the effects only in the preferable ranges illustrated as the examples. Similar effects can also be expected in the case of recording media produced by freely and suitably changing the composition of the reflective film illustrated.

In addition, in the above series of examples, the explanation was given illustrating predetermined thicknesses when forming the reflective films, but the invention according to this application is not limited to only the exemplified

thicknesses. While detailed data will be omitted, according to experiments of the inventors of this application, when making the thickness of the reflective film 500Å, the heat able to be used for writing at the magnetic film ends up dissipating through the reflective film and it was difficult to obtain a good recording power. Further, when making the thickness of the reflective film 100Å, the reflective film itself becomes permeable and an effective Kerr enhancement effect cannot be obtained and therefore the decrease in CN ratio and increase in recording power are conspicuous. Accordingly, in applying the present invention, a magneto-optical recording medium having a good recording sensitivity can be realized if setting the thickness of the reflective film to 200 to 400Å or so.

It is clear that the materials, thicknesses, numerical conditions and other specific conditions can be suitably modified and changed within the range of the object of the present invention.

(Effects of the Invention)

As will be apparent from the foregoing description, according to the magneto-optical recording medium according to the first aspect of the invention of this application, by forming a reflective film of silver (Ag) and manganese (Mn), it is possible to utilize the reflectivity of Ag and lower the thermal conductivity of the reflective film by the Mn.

Further, according to the magneto-optical recording medium according to the second aspect of the invention of this application, by forming a reflective film of silver (Ag), manganese (Mn), and tin (Sn), in the same way as the first aspect of the invention, it is possible to utilize the reflectivity of Ag and lower the thermal conductivity of the reflective film by the Mn and Sn.

Thus, by working the first aspect and second aspect

according to this application, it is possible to maintain a practically sufficient CN ratio and further realize a low thermal conductivity to thereby reduce the recording power and provide an excellent magneto-optical recording medium.

4. BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram showing correlation curves with the ordinate and the abscissa representing the recording power and the Mn addition rate in Ag-Mn respectively, which illustrates Example 1 in accordance with the first aspect of the present invention;

FIG. 2 is a diagram showing correlation curves with the ordinate and the abscissa representing the CN ratio and the Mn addition rate in Ag-Mn respectively, which illustrates Example 1 in accordance with the first aspect of the present invention;

FIGS. 3(A) and (B) are diagrams each showing correlation curves with the ordinate and the abscissa representing the recording power and the Sn addition rate in Ag-Mn-Sn, respectively, which illustrate Example 2 in accordance with the second aspect of the present invention;

FIGS. 4(A) and (B) are diagrams each showing correlation curves with the ordinate and the abscissa representing the CN ratio and the Sn addition rate in the Ag-Mn-Sn, respectively, which also illustrates Example 2 in accordance with the second aspect of the present invention; and

FIGS. 5(A) and (B) are explanatory views showing by schematic cross-sections the configuration of a magneto-optical recording medium for explaining the prior art and examples.

11... substrate, 13a, 13b... protective film,

15... magnetic film, 17... reflective film,

19, 21... magneto-optical recording medium

FIG. 1. EXPLANATORY VIEW OF EXAMPLE 1

RECORDING POWER

MN ADDITION RATE IN AG-MN (ATOMIC%)

FIG. 2. EXPLANATORY VIEW OF EXAMPLE 1

CN RATIO

MN ADDITION RATE IN EXAMPLE 1 (ATOMIC%)

FIG. 3(A). EXPLANATORY VIEW OF EXAMPLE 2

RECORDING POWER

SN ADDITION RATE IN AG-MN-SN (ATOMIC%) (CASE OF THICKNESS OF REFLECTIVE FILM OF 400Å)

FIG. 3(B). EXPLANATORY VIEW OF EXAMPLE 2

RECORDING POWER

SN ADDITION RATE IN AG-MN-SN (ATOMIC%) (CASE OF THICKNESS OF REFLECTIVE FILM OF 200Å)

FIG. 4(A). EXPLANATORY VIEW OF EXAMPLE 2

CN RATIO

SN ADDITION RATE IN AG-MN-SN (ATOMIC%) (CASE OF THICKNESS OF REFLECTIVE FILM OF 400Å)

FIG. 4(B). EXPLANATORY VIEW OF EXAMPLE 2

CN RATIO

SN ADDITION RATE IN AG-MN-SN (ATOMIC%) (CASE OF THICKNESS OF REFLECTIVE FILM OF 200Å)

FIG. 5. EXPLANATORY VIEW OF PRIOR ART AND EXAMPLES

11: SUBSTRATE, 13A, 13B: PROTECTIVE FILM, 15: MAGNETIC FILM, 17: REFLECTIVE FILM, 19: MAGNETO-OPTICAL RECORDING MEDIUM

21: MAGNETO-OPTICAL RECORDING MEDIUM